Automation for construction equipment request and deployment for emergency response

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Access to heavy equipment is critical to disaster response operations (Gentes, 2006); efficient request and deployment of construction equipment is vital to lifesaving operations. Heavy equipment is required during emergency operations such as 1) rapid debris clearance of the transportation network for first response teams to reach to blocked hazard zones, 2) careful lifting of damaged structural elements, and 3) selected debris removal to clear structural materials which facilitates void space searches and tunnelling under collapsed buildings. However, in major disasters the social infrastructure is not always able to provide immediate supply of heavy construction equipment to support disaster response operations (Gill, 2007). Because the probability of rescuing victims -- trapped under a collapsed building-- decreases 50% after the golden 24 hours, delay in rescue operations due to inefficient equipment deployment could result to more casualties (Bissell et al., 2004). Heavy equipment, which supports critical lifesaving activities, should be efficiently located, assigned and distributed to meet the urgent demands. Decisions such as collection, prioritization and distribution of resources thus need to be made efficiently to have the response system effectively support life-saving operations.

GIS is an essential tool for mapping locations, visualizing dynamic conditions, and making decisions in disasters. Geospatial data and tools are useful in response to disasters; Real-time data fusion and analysis can be achieved through GIS during the response phase for fast decision-making. Significant research has been conducted in GIS that focused on areas such as route planning (Kwan and Lee 2005), data visualization (Chen et al., 2008), and risk management (Hu et al., 2008). However, GIS for emergency management with rapid capability and access of data and the tools that work under difficult circumstances of urban search and rescue (US&R) have rarely been addressed (NRC, 2007).

A client-server application has been implemented with C# using ESRI’s ArcGIS Engine to automate the equipment request process. In Figure 1, the client application sends request information in XML format to the resource management server via computer networks. The server match the request with the inventory stored in the database and deploys the equipment. Current policy of deployment is based on a first in first out (FIFO) basis and the server plans the route from the resource depot to the destination based on shortest travelling time on the network. The types of equipment first responders can choose from, in dropdown lists, are categorized into Resource Category (such as Fire Hazardous Materials, Incident Management, Search and Rescue), Resource Name, and Resource Type (NIMS type I to V). The NIMS typing is a standard resource typing used by the Federal Emergency Management Agency (FEMA).

As a result, a first responder can request equipment on the disaster site through clicking on a user interface on a PDA/smart-phone; first responders can acquire equipment more efficiently through the
software application. Less time overhead shortens the response time. With the application in place, lifesaving efforts are expected to be carried out with better efficiency. Future expansion of the application will be towards automation of complex decision-making such as prioritization of limited resources.

Figure 1 Client Server Application for Equipment Request

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References


